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EFFECTS OF ROAD CONSTRUCTION ON WETLANDS  
IN A DEAD-ICE MORaine

by

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A thesis submitted to the Graduate Faculty in partial  
fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Fish and Wildlife Management

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June, 1972

## VITA

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## ACKNOWLEDGMENT

I wish to extend my sincere appreciation to the following for their contributions to this study: Dr. R. L. Eng, Montana State University, for project planning, technical supervision and guidance in preparation of the manuscript; Dr. W. J. D. Stephen, Mr. Gordon Staines and my brother, Dennis C. Crendi, for suggestions in project planning, assistance and preparation of the manuscript; Dr. D. C. Quimby and Dr. R. J. Graham of Montana State University for critical reading of the manuscript; Mr. J. Bussard from the Alberta Department of Highways for cooperation in selecting the study area; the Canadian Wildlife Service for financial support and encouragement; and to my wife, Sally, without whose patience and understanding this study could not have been completed.

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ABSTRACT

A study of the effects of road construction on wetlands in the Dead-ice moraine of south-central Alberta was conducted during the summer and autumn of 1971. The study area consisted of 27 treated ponds along rights-of-way on which roads had been constructed and 32 control ponds located away from the treated areas. Measurements of basins before and after road construction were taken from air photos by outlining the original basin, measuring its area and shoreline, then measuring the area and shoreline of the basin, including road alterations. A 5.6 percent loss in area and an 11.5 percent gain in shoreline were found to have occurred due to the presence of the road. Aerial surveys by helicopter were made to determine if differences existed in duck use between ponds near the road and those away from the road. No difference in total duck use was detected, but some differences in preference by species was indicated.

## INTRODUCTION

Personnel of the Canada Land Inventory, mapped approximately 45,000 square miles of moraine areas in Alberta and rated them as good to excellent waterfowl habitat. According to the Public Lands Act of Alberta, every quarter section of land which has been legally surveyed must be accessible. This has resulted in a grid system whereby east-west road allowances are located two miles apart, and north-south allowances are located one mile apart. These allowances range in width from 132 to 150 feet with an equal portion taken from each section. As settlement increases, the need for roads also increases and the road allowance, with a small construction input then becomes a trail. As traffic trends develop, heavily used trails are then upgraded and become secondary or "market roads".

Every year, personnel of the U. S. Fish and Wildlife Service conduct aerial breeding pair and production surveys in sample areas of North America. In southern Alberta (and the other prairie provinces) these surveys are conducted along the grid roads which are used as navigation aids. Because of this, there is a need to determine whether the roads have significantly altered the habitat and if duck use in the wetlands along the road is different from that in habitat unaltered by roads.

Flooding of road allowances occurs periodically, which provides a problem as long as no roads have been developed. However, as soon as a

road achieves the status of a market road and drainage of a low area is possible, a wetland may be eliminated. One typical case is well documented in central Alberta where drainage of a flooded road allowance resulted in a loss of one hundred acres of excellent waterfowl habitat (C. Surrondi 1967).

To date, little work has been done regarding the effects of grid road construction and reconstruction on wetlands in morainic areas. The purpose of this study was to investigate the effects of road construction on the morphology of ponds in dead-ice moraine located in the aspen parklands of south-central Alberta.

### DESCRIPTION OF THE STUDY AREA

The study area, a strip eight miles long and one mile wide, was located 12 miles northeast of the town of Stettler, Alberta (Fig. 1). Land use in the area is primarily agricultural with emphasis on live-stock production and dry land grain farming. For the past 30 years, annual precipitation has averaged 16.06 inches (Ministry of Transport Climatological Division, Edmonton International Airport, 1971). The area has been described as "... a poorly drained region situated on relatively young glacial drift, comprising mostly ground and end moraine. The till of which the moraines are formed was deposited in a rolling topography consisting of low hills and undrained depressions. The low bodies of water known locally as sloughs ... may range in number from a few to 120 or more per square mile" (Bird 1961).

As may be inferred by the name, "aspen parkland", the dominant vegetation type is quaking aspen (*Populus tremuloides*). Balsam poplar (*Populus balsamifera*) and several species of willow (*Salix* spp.) are in lesser abundance. The trees listed above are found throughout the region in mesic and hydric sites with the willows frequently found within the pond edges.

The understory of the aspen-poplar groves is comprised of shrubs and forbs. The shrub layer is comprised of choke cherry (*Prunus virginiana*), Saskatoon berry (*Ameiuchier alnifolia*), beaked hazel (*Corylus cornuta*), red-osier dogwood (*Cornus stolonifera*), and rose

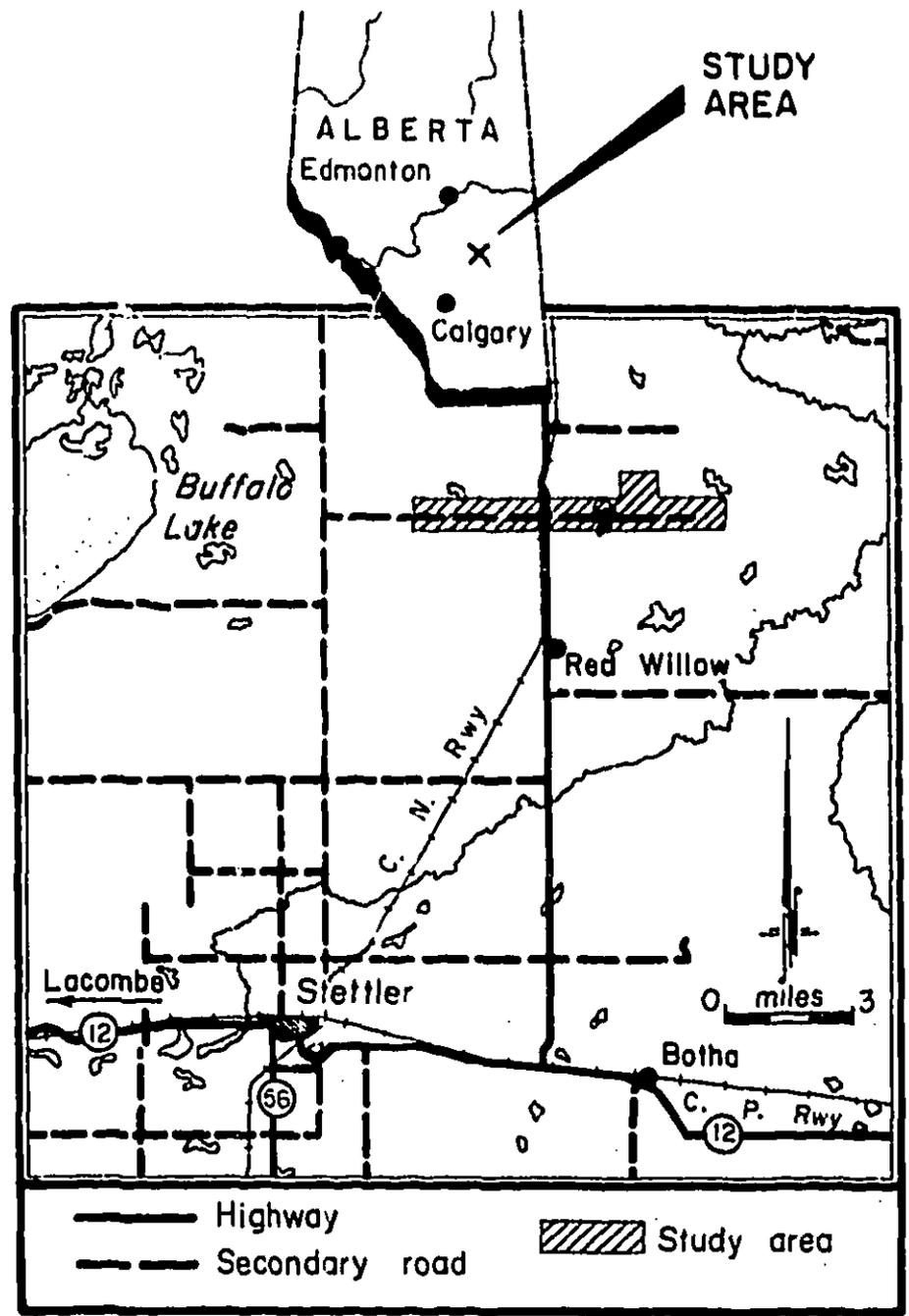


Figure 1. Map showing location of study area.

(*Rosa* spp.). The margins of the aspen groves are comprised of smaller shrubs such as snow berry (*Symphoricarpos* spp.), silver willow (*Salix glauca*) and red raspberry (*Rubus strigosus*). The herb layer consists primarily of northern bed straw (*Galium boreale*), Solomon's seal (*Smilacina stellata*), and wintergreen (*Chamaenerion angustifolium*).

A short grass prairie community present on the elevated, more xeric sites is characterized by spear grass (*Stipa comata*), fringed sage (*Artemisia frigida*) a half shrub, and forbs such as three-flowered avens (*Germ. triflorus*), purple prairie clover (*Fetalostemon purpureum*) and pussy toes (*Antennaria* spp.). Gumweed (*Grindelia* spp.) occurs in disturbed areas along with several species of thistles (*Cirsium* sp.) and asters (*Aster* spp.).

In the ponds, emergent vegetation is characterized by sedges with *Carex rostrata* and *C. atherodes* being the most abundant species. Associated with the sedge communities are varying amounts of other emergents such as cattail (*Typha latifolia*), slough grass (*Beckmannia sylvatica*), baltic rush (*Juncus balticus*), arrow grass (*Triglochin maritima*), bladder wort (*Utricularia vulgaris*), persicaria (*Polygonum* spp.), and bulrush (*Scirpus* spp.). Pond weeds (*Potamogeton* spp.) are the most abundant submergents while coontail (*Ceratophyllum* spp.), water milfoil (*Myriophyllum exalbescens*) and duck weed (*Lemna* spp.) are present in lesser amounts. A graphic description of the fauna in this region exists in Bird (1961).

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The road surfaces in the study area are gravel and vary from 24 to 30 feet wide with back slopes varying from a 2 to 1 to a 1 to 1 ratio, (James Bussard, Alberta Department of Highways, personal communication) both of which form deep ditches. The roads are raised above the general ground level to facilitate snow removal during the winter.

The road in the area of study was typical of those in the dead-ice moraine region as it touched or passed through numerous wetlands. It had been in existence for 23 years. This time interval was sufficient to allow for establishment of vegetation following disturbance. Air photos of the area were available for periods both before and after road construction.

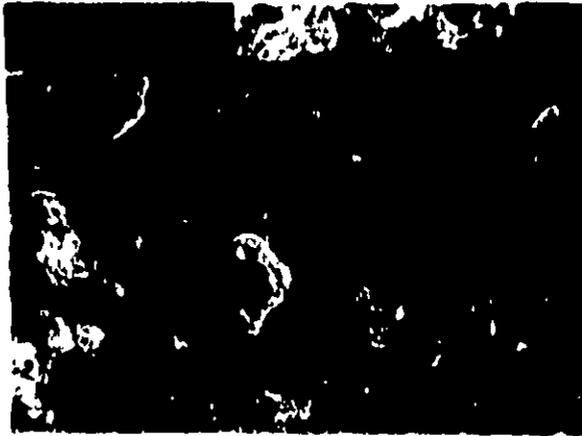
## METHODS

Twenty-seven ponds along eight miles of road were designated as "treated" because all had been modified by road construction. Thirty-two ponds occurring along lines one-fourth mile on either side of, and parallel to the road were selected as controls. None of the control ponds touched a road allowance.

Comparison of air photos taken before and after construction of the road indicated that while water levels and quality of photos varied, the general configuration of the basins remained the same. Therefore, all measurements were made on air photos (scale 1 inch = 704 feet) taken in September 1948, to avoid errors caused by photo quality or parallax distortion (Agriculture Handbook 294, Soil Conservation Service, U. S. Department of Agriculture, pp. 11). As can be seen on a photo of pond No. Ex. 8-3 (Fig. 2a), the road allowance is well defined. The original basin was outlined and total shoreline and area measured (Fig. 2b). The road allowance was outlined and measurements were again taken to assess any changes in total shoreline and area (Fig. 2c). Shoreline was measured with a map wheel and area with a planimeter. All measurements were made three times and the average used.

Ground counts of broods were only made on the treated ponds. They were conducted on July 16 and August 10. Counts from a helicopter, covering both treated and control ponds, were made on July 17 and August 7. Ground and air counts were made as close together in time as

- a. A 1948 air photo of pond No. Ex. 8-3 - before measurements were taken. The road allowance is well defined as is the high water mark.



- b. Black line indicates where measurement was taken to determine original basin area.



- c. Black line on both sides of the road indicate the area that the road removed from the pond as well as the shoreline which was added to the pond.

Figure 2. Enlarged aerial photographs showing procedure for obtaining measurements.

possible to minimize effects of brood movements between surveys. All counts were started at about 6:00 a.m.; no counts continued past noon. No counts were made when high winds or heavy rains prevailed.

Aerial counts on ponds of less than two acres and surrounded with low growing vegetation were made from heights of about 30 feet. For larger ponds (3 acres or more) and all ponds surrounded by trees and/or powerlines, censuses were made from about 60 feet. Where emergent vegetation was dense, lower elevations were flown, allowing the down draft from the helicopter to flatten the vegetation, providing some increase in visibility. Aerial count data were recorded on a Phillips tape recorder. "Beat outs" (Diem and Lu 1960) were abandoned because of density of vegetation and because I worked alone. Ground counts were made from vantage points with the aid of a 20X spotting scope and/or 7X binoculars. Brood counts were used to provide a duck use index and not a measure of total production. All counts were made from east to west to standardize the time at which each pond was surveyed.

Plant nomenclature is that of Cormack (1967) and Alberta Department of Lands and Forest publication, "Trees and Shrubs of Alberta" (1966). Waterfowl nomenclature is as listed in Salt and Wilk (1969).

Statistical analyses were performed as described by Ostle (1963) and Sokal and Rohlf (1969).

## RESULTS

### Physical Relationships

The 27 pond basins in the treated area, prior to and after road construction, measured 63.50 and 59.94 acres respectively, a loss of 5.6 percent. Small losses were measured on all but three ponds. A paired "t" test showed the loss to be significant ("t" = 6.0, d.f. = 26 at 95 percent level). Therefore, it may be inferred that road construction reduced the overall wetland area.

Map wheel measurements on the 27 treated ponds before and after the alterations yielded a total of 6.94 and 7.72 miles of shoreline respectively. This was an increase of 11.5 percent. A paired "t" test on these data showed that the increase was significant ("t" = 6.0, d.f. = 26 at 95 percent level). Almost every pond showed an increase in shoreline length. The most striking changes occurred in the smaller ponds (0.1 to 2.0 acres) with some having their shoreline length almost doubled by the intrusion of the road. Before road construction, 6.94 miles of shoreline for 63.50 acres of basin averaged 0.11 miles of shoreline per acre. After construction there was 7.72 miles of shoreline and 59.94 acres of ponds for an average of 0.13 miles of shoreline per acre. The shoreline for the control basins totaled 7.36 miles around 54.13 acres, for an average of 0.14 miles of shoreline per acre. When compared with control ponds, the treated ponds showed no significant difference in shoreline miles per acre before ( $\chi^2 = .0036$ , d.f. = 1 at

95 percent level) or after ( $\chi^2 = .00036$ , d.f. = 1 at 95 percent level) road construction.

Depth differences between the treated and control ponds were suggested by the vegetation present. Vegetation covered about 41 and 53 percent of the area in the treated and control pond basins respectively. This difference is not statistically significant ( $\chi^2 = 1.520$ , d.f. = 1 at 95 percent level). However, in the treated area only one pond (3.5 percent) was completely covered by vegetation whereas the control area had 22 ponds (52 percent) completely covered. This difference is highly significant ( $\chi^2 = 42.4$ , d.f. = 1 at 95 percent level). Dabbs (1971), in his book on *Scirpus acutus* and *Scirpus validus*, both of which are found on my study area, showed that *S. acutus* had a tolerance of from 60 to 150 cm while *S. validus* occurred only in depths of less than 65 cm. The fact that most ditches were free of vegetation (Fig. 3) and that *Scirpus* spp., particularly *S. acutus*, were abundant in the area allows one to assume that water depth in the ditches was at least deeper than 60 cm (23.6 in.) and perhaps over 150 cm (> 50.1 in.).

#### Waterfowl Use

On the treated area during the first ground count (July 16), 31 broods or 0.5 broods per acre were seen. During the first air survey one day later, 35 broods, or 0.6 broods per acre, were counted. These figures are not significantly different ( $\chi^2 = 0.38$ , d.f. = 1 at 95 percent level).



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Figure 3. Photo typifying a road passing through a permanent pond.

During the second survey, 38 broods were observed from the ground (August 10) and 74 broods were observed from the air (August 7). These numbers differ significantly ( $\chi^2 = 11.6$ , d.f. = 1 at 95 percent level). Broods per acre from ground and air surveys were 0.6 and 1.2 respectively. The large increase in broods during the second aerial count may be attributable to several factors. By the second survey date more broods may have matured to a point where they were more easily seen from the air, some broods may have moved to the larger, more open ponds, or an ingress of broods may have occurred from ponds outside the study area.

In comparing the number of broods on the treated and control areas, only aerial surveys were used. During the July 17 survey, 33 and 35 broods were seen on the treated and control ponds respectively. There were 0.6 broods per acre in both treated and control areas.

During the August 7 air survey, 74 and 65 broods were observed on the treated and control ponds respectively, yielding an identical duck use index of 1.2 broods per acre for both areas.

A classification of broods for each survey is shown in Table 1. Of the 51 classified broods from the July 17 survey (treated and control areas), 39.2 percent were mallards (*Anas platyrhynchos*), 39.2 percent were blue-winged teal (*Anas discors*), 15.7 percent were other dabblers, and 5.9 percent were divers. There were 17 unidentified broods which were not included in determining duck species composition.

Table 1. Species composition of broods observed in both areas  
(experimental and control) during two aerial surveys.

	Survey No. 1	Survey No. 2
Mallards	20	35
Blue-Winged Teal	20	35
Other Dabblers	8	29
Divers	3	3
Unidentified Broods	17	37
	—	—
Total	68	139

In the August survey 102 broods were classified of which 34.3 percent were mallards, 34.3 percent were blue-winged teal, 28.4 percent were other dabblers and 2.9 percent were divers. There were 37 unidentified broods which were excluded in determining species composition. The distribution of the species did not change significantly from survey 1 to survey 2 ( $\chi^2 = 3.57$ , d.f. = 4 at 95 percent level).

When mallards and blue-winged teal are considered separately and their brood numbers compared between control and treated areas, some differences are noted (Fig. 4). When both surveys were combined there were 31 blue-winged teal broods seen along the road and 24 seen in the control ponds. Although there was a trend toward heavier use of the treated areas by blue-winged teal, this was not statistically significant ( $\chi^2 = 0.89$ , d.f. = 1 at 95 percent level). There were 17 mallard broods seen in the treated areas and 38 in the control areas. This difference was significant ( $\chi^2 = 8.0$ , d.f. = 1 at 95 percent level).

No special effort was made to determine the value of the roadside within the confines of a pond as nesting cover. However, where the surrounding land-use was intensive grain farming, roadside vegetation was the only nesting cover available (Fig. 5). Predation by skunks and crows on these long narrow bands of cover was evident (Rearden 1951), although several successful waterfowl nests were found including those of lesser scaup (*Aythya affinis*) (Fig. 6), shoveler (*Spatula clypeata*), pintail (*Anas acuta*), mallard and blue-winged teal. Nest destruction

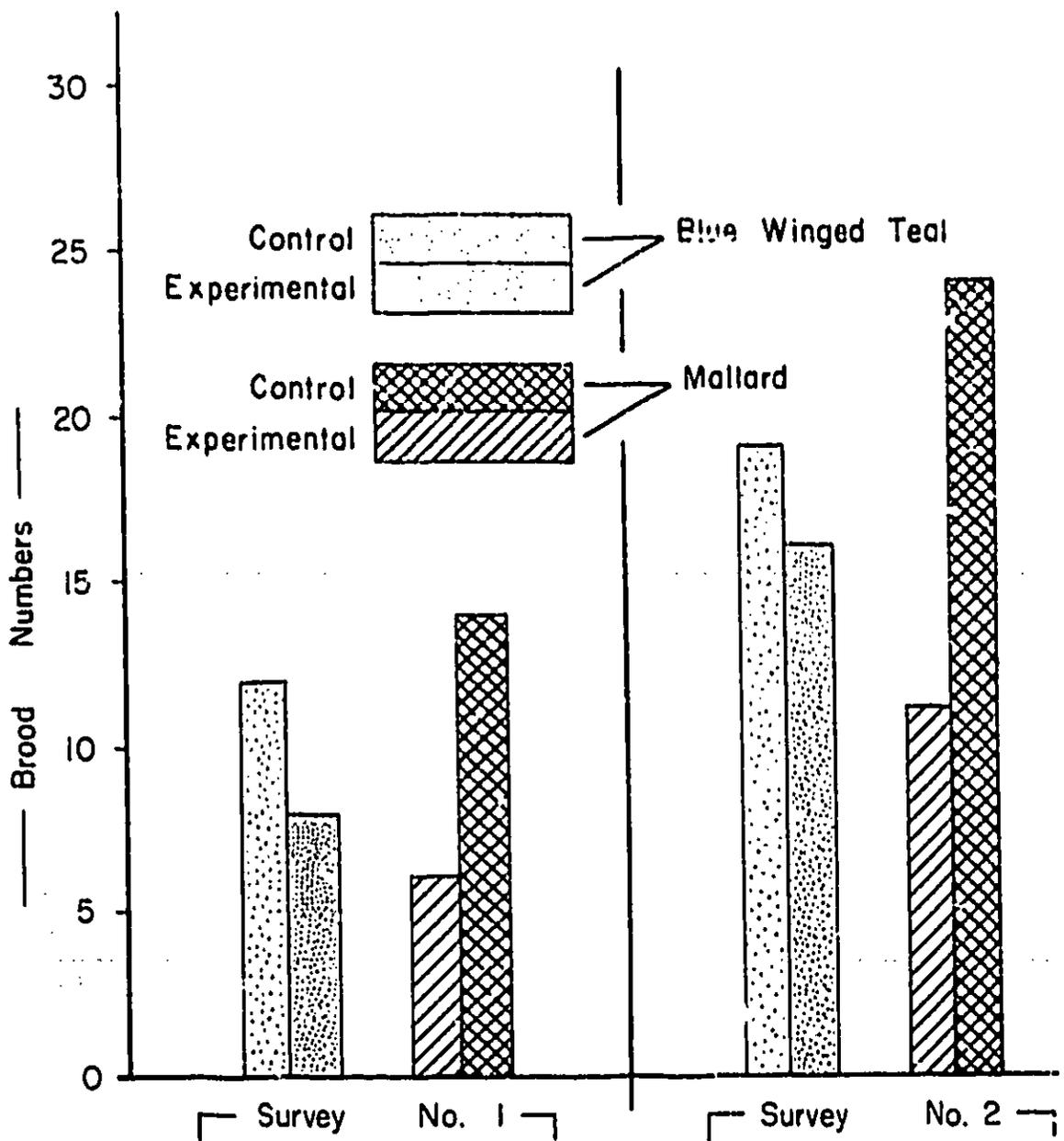


Figure 4. Numbers of blue-winged teal and mallard broods on the treated and control areas for two aerial counts.



Figure 5. Photo of pond on study area shows lack of nesting cover due to grain cropping down to shoreline. Waterfowl nest in cover along the road.

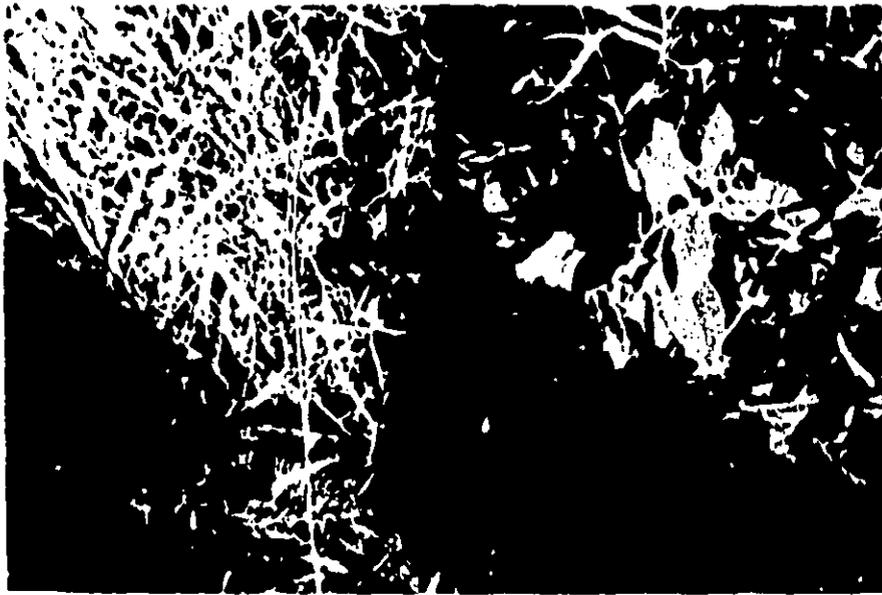
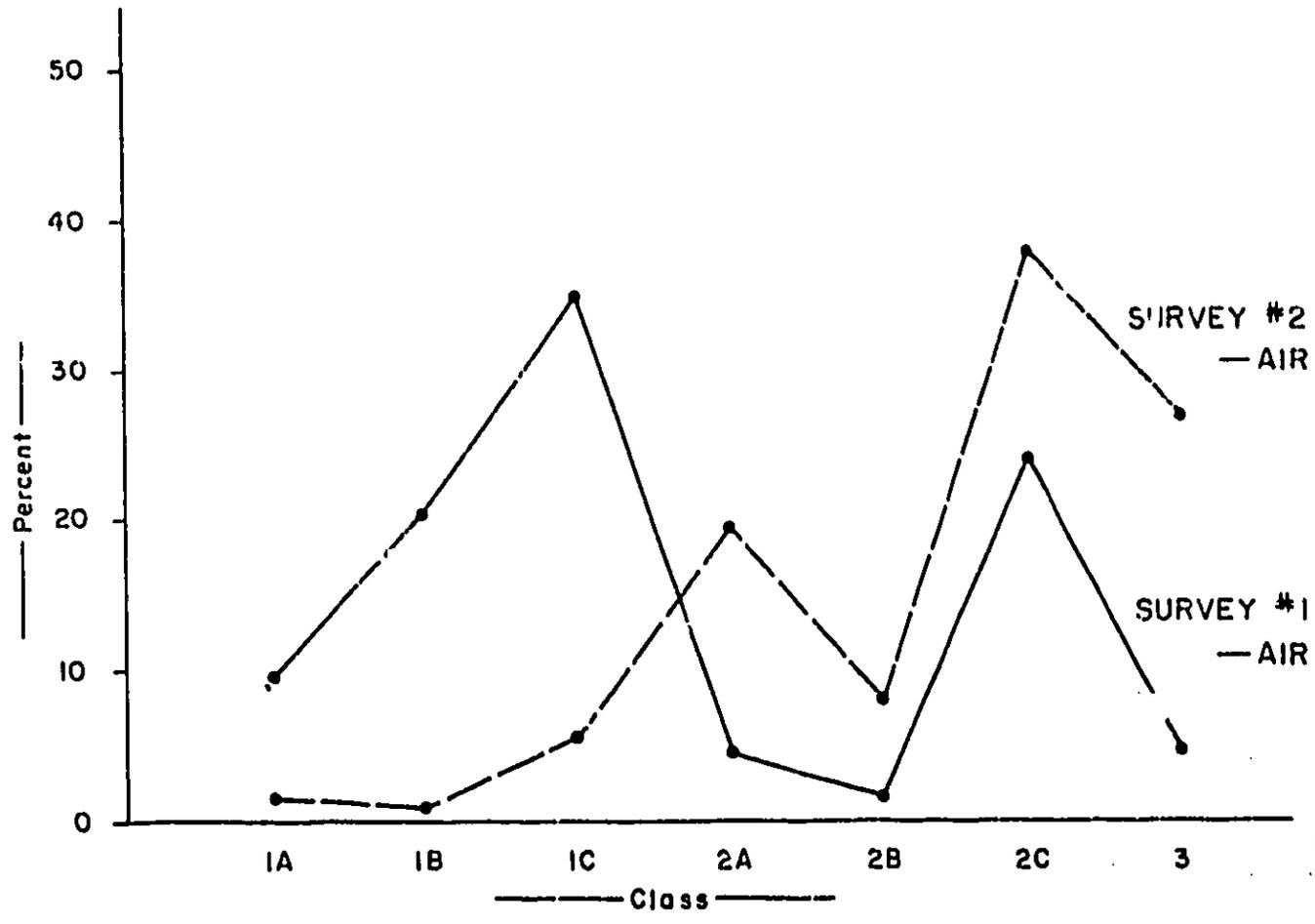


Figure 6. Lesser scaup nest containing ten eggs was located along roadside shoreline of pond Ex. 7-3.

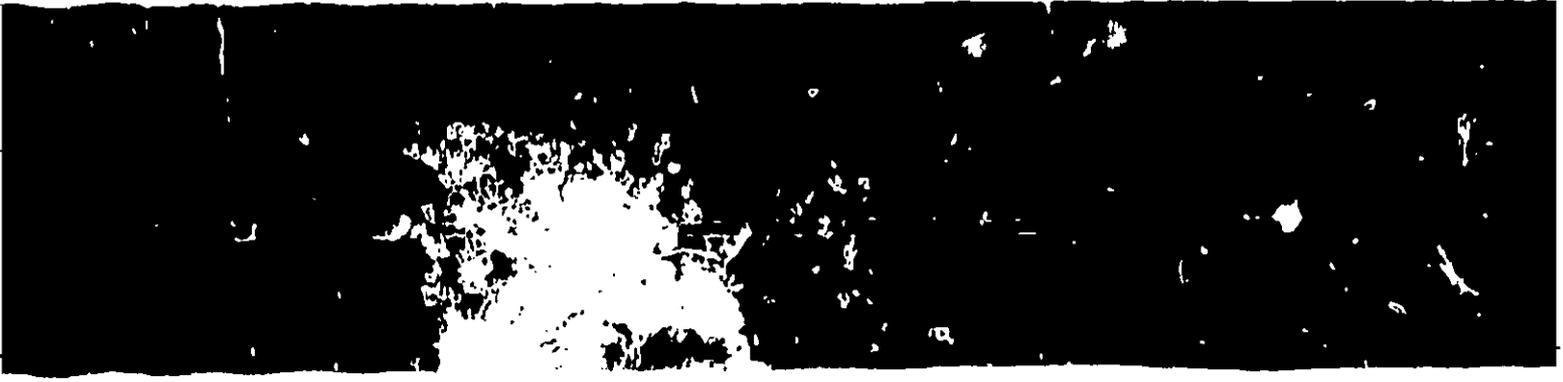
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along narrow strips of cover and resulting re-nesting effort probably accounted in part for the wide distribution of the hatch. Class 1a, 1b, and 1c broods (Gollop and Marshall 1951) made up at least 10 percent of the broods observed during the August 7 survey (Fig. 7).



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Figure 7. Distribution of age classes between air surveys #1 and #2.



## DISCUSSION

It was quite evident in this study that road construction resulted in a loss of basin acreage (5.6 percent) and an increase in shoreline length (11.5 percent) on ponds along the rights-of-way. Sorensen and Isbister (1970), in comparing water areas along roads with water areas on comparable strips away from roads, found 18 percent less acreage and 18 percent less shoreline along the roads. This inferred loss of acreage due to road construction may be due to their having made these comparisons in several different land forms, including river valleys and sloping till plains, both of which would easily allow complete drainage of some basins during road construction. My study was confined to a dead-ice moraine, a land form in which drainage is more difficult.

The inferred loss of shoreline in the strips along roads reported by Sorensen and Isbister (1970) was in direct contrast to the gain recorded in my study. Again, the primary reason for this discrepancy probably lies in the differences in land forms studied. The inferred loss of shoreline undoubtedly was due to the elimination of individual ponds. No loss of ponds was recorded in my study.

Many of the treated ponds would have been classified as Class II temporary ponds (Stewart and Kantrud 1971) prior to road construction. Following construction, resulting borrow pits frequently increased the depths of these ponds. This increase in depth influenced the water

retention capability and the distribution of emergent vegetation.

Precipitation was unusually heavy during the two years prior to and during the summer of the study (Ministry of Transport Records, Edmonton International Airport 1971). There were losses of only three temporary ponds in the control area and none in the treated area during this study. This suggests that ponds in the treated area would last longer than those in the control area under less favorable moisture conditions. This is supported by the work of Sorensen and Isbister (1970) who found that by mid-summer, during a period of less than average rainfall, 41 and 34 percent of the basins along the road and away from the road, respectively, hold water.

One transect used by the U. S. Fish and Wildlife Service for breeding pair surveys passes through the study area. Direct comparisons with my surveys were not possible because my counts of broods were made in mid-July and early August, while those of the U. S. Fish and Wildlife Service were made in mid-May on breeding pairs, lone drakes, flocked drakes and lone hens. Even so, during my August survey, the number of broods observed on the study area outnumbered the potential breeding pairs indicated by the U. S. Fish and Wildlife survey by 139 to 122. This may indicate that a helicopter census is more efficient than one from a fixed wing aircraft. It is also possible that movement of broods may have occurred onto the more permanent ponds along the road. During periods of limited precipitation, such ponds may play an



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important role as "salvage" areas for waterfowl.

When a road is constructed, small collecting basins are frequently created in ditches or borrow pits. Many of these "new" basins, although too small to measure from air photos, were utilized by lone drakes and pairs, particularly blue-winged teal. These small basins may aid in the dispersal of breeding pairs and provide an additional attractant for ducks to the areas along the roads.

I conclude from this study that road construction in dead-ice moraine results in measurable differences in the characteristics and use of the wetlands involved. Loss in basin area and increase in shoreline were noted. Perhaps more important was a suggested increase in water depth and permanency reflecting a change in vegetation cover. Blue-winged teal were observed to use the treated ponds to a greater degree than the control ponds. The reverse was true for mallards, but in a more pronounced manner. These observations were recorded during a year of above average moisture conditions. It is the feeling of this author that during a period of below average or even average moisture conditions, the differences between wetlands near the road and those away from the road would be even more measurable.

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